

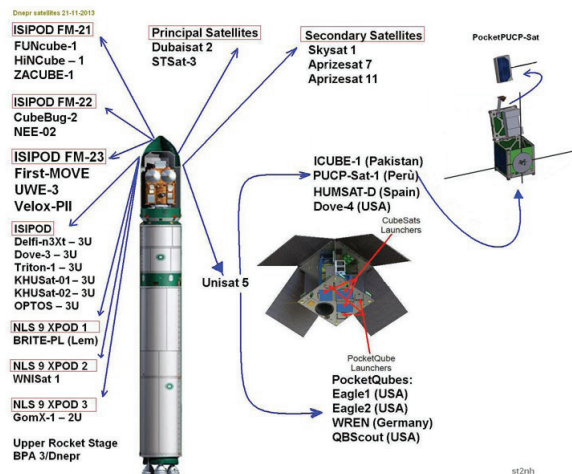
The AMSAT[®] Journal

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Volume 36, Number 6

November/December 2013



FUNcube-1 and 36 more cubesats launched in November!



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AMSAT Board Elects Senior Officers for 2014

Election of AMSAT's Senior Officers was one of the first orders of business at the AMSAT Board of Directors meeting on October 31 in Houston, Texas.

The following positions were voted upon and filled:

- Barry Baines, WD4ASW – President
- Drew Glasbrenner, KO4MA – Vice-President Operations
- Gould Smith, WA4SXM – Vice President User Services
- Tony Monteiro, AA2TX – Vice-President Engineering
- Frank Bauer, KA3HDO – Vice-President Human Spaceflight
- Alan Biddle, WA4SCA – Secretary
- Keith Baker, KB1SF/VA3KSF- Treasurer
- Martha Saragovitz – Manager

The following positions were filled by appointment by the AMSAT President:

- Patrick Stoddard, WD9EWK - Vice-President Field Operations
- EMike McCardel, KC8YLD – Vice-President Educational Relations
- Steve Belter, N9IP - Dayton Hamvention Ops
- David Taylor, W8AAS - ARISS International Delegate
- Maurice-André Vigneault, VE3VIG - ARISS International Delegate
- JoAnne Maenpaa, K9JKM - Editor, *AMSAT Journal*
- Lee McLamb, KU4OS - Senior Editor AMSAT News Service

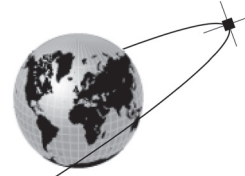
AMSAT's Mission

AMSAT is a non-profit volunteer organization which designs, builds and operates experimental satellites and promotes space education. We work in partnership with government, industry, educational institutions and fellow Amateur Radio societies. We encourage technical and scientific innovation, and promote the training and development of skilled satellite and ground system designers and operators.

AMSAT's Vision

Our Vision is to deploy satellite systems with the goal of providing wide-area and continuous coverage. AMSAT will continue active participation in human space missions and support a stream of LEO satellites developed in cooperation with the educational community and other amateur satellite groups.





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The past month has been a very busy and fun time for AMSAT and for amateur radio in space. With the approaching holiday season, there is certainly much to highlight.

AMSAT Space Symposium

The 31st AMSAT Space Symposium and Annual Meeting was an outstanding success in Houston, TX the weekend of 1-3 November. The organizing committee, led by Lou McFadin, W5DID and ably assisted by members Nick Lance, KC5KBO and Kenneth Goodwin, K5RG of the Clear Lake Amateur Radio Club, did a magnificent job of getting the myriad of details handled that resulted in a very good Symposium. A number of Symposium-related tasks were delegated, such as Alan Biddle, WA4SCA and Bernhard Jatzeck, VA6BMJ managing the recognition process (awardees received wooden plaques made by Bill Stoltz, K5YRT of "Ham Plaques"), Frank Bauer coordinated the banquet panel that discussed 30 years of amateur radio involvement in human space flight, Dan Schultz, N8FGV once again served as editor/publisher of the "Proceedings", Dave Jordan, AA4KN and his team assisted with managing the prizes, and of course Martha Saragovitz dealt with the hotel on the many details regarding meals, meeting spaces and coordinating with the Symposium Committee.

Among the highlights of this year's Symposium:

The Proceedings of the AMSAT-NA 31st Space Symposium and AMSAT-NA Annual Meeting totals 415 pages. About 200 of those pages are technical materials pertaining to AMSAT's Fox-1 Cubesat project as we use the Proceedings to place Fox-1 materials in the public domain through printed publication so that we can present technical information in public forums where foreign nationals may be present.

There were 23 presentations made on Friday and Saturday covering a variety of topics. Indeed, three of the presentations were materials not included in the Proceedings.

The Friday night reception was well attended, providing an opportunity for an informal gathering of attendees.

The AMSAT Annual Meeting was held Saturday following the conclusion of presentations. Along with those individuals attending Symposium, we also used Echolink to provide an opportunity for AMSAT members to listen to the meeting

as well. This year we had 17 individuals participating through this medium.

One of the functions of the Annual Meeting is for the President to provide an annual report to the membership. If you're interested in seeing my slide presentation, it can be found at the AMSAT website. After making my presentation, I asked for questions and received none from the attendees. I don't know if that means I covered everything to everyone's satisfaction or if the areas I covered were not of significant interest to those who saw the presentation. If you review my slides and have any questions about what was presented, please don't hesitate to contact me (wd4asw@amsat.org).

Following the Annual Meeting, AMSAT recognized 73 individuals for their accomplishments on behalf of AMSAT in 2013. Each person was given a wooden plaque with their name/callsign and a brief statement concerning their impact on AMSAT.

The Saturday evening banquet was well attended (over 120 individuals). The highlight was the panel discussion honoring 30 years of amateur radio involvement in human space flight. Moderated by AMSAT VP-Human Space Flight Frank Bauer, KA3HDO the panel included:

- Owen Garriott, W5LFL who was the first astronaut to use amateur radio in space on Shuttle Mission STS-9 in November 1983.
- Bill McArthur, KC5ACR served as Commander on the International Space Station Expedition 12 and was an avid amateur operator on ISS.
- Former AMSAT VP-Human Space Flight (and later President) Bill Tynan, W3XO who worked with NBC News Correspondent Roy Neal, K6DUE to convince NASA to allow amateur radio operations on the Space Shuttle.
- Former NASA employee Lou McFadin, W5DID who handled much of the technical details of preparing amateur radio equipment for flight and gaining

continued on page 4 ...





NASA approval for placement on the Shuttle. Lou continues to be heavily involved in amateur radio construction and integration of amateur equipment on the ISS as the ARISS Hardware Manager.

- Tim Bosma, W6MU serves as a ground station operator heavily involved in ARISS telebridge activities.

Frank asked each panelist questions pertaining to their area of interest and experience that helped to tell the story of how amateur radio first flew on the space shuttle and how that beginning has grown into ARISS. Video clips taken when Owen flew on STS-9 provided context of what was said at the time about amateur radio's participation in human space flight.

The banquet presentation was indeed a special event that highlighted a significant milestone for amateur radio in space. This same tradition continues today.

The AMSAT prizes were drawn after the banquet presentation. The top three prizes were:

- Kenwood TS-2000 won by Anne Carpenter of Houston, TX. She directed that the transceiver be shipped to her mother, Nancy Makley, KC8GYW who was also at the banquet.
- FlexRadio Systems Flex-1500 QRP SDR won by Jerry Buxton, N0JY of Granbury, TX
- M-Squared, Inc. antennas won by Lou McFadin, W5DID of Orlando, FL

Our thanks for our major prize contributors as well as our other donors who provided some very interesting items. Elecraft, for example, donated a prize to AMSAT for the first time, providing a nice piece of test equipment, the XG3 Programmable Signal Source (1.5-1400 MHz). A list of prize donors will be included in the Symposium full coverage reporting in the January/February issue of the *Journal*.

The Sunday morning Field Operations Breakfast was attended by about 25 area coordinators and led by Director-Field Ops Patrick Stoddard, WD9EWK. Patrick is working hard to get the Field Operations department back in full operation.

Hans Van de Groenendaal, ZS6AKV held the IARU Satellite Advisor Forum on Sunday morning. Hans alternates his forum yearly between the AMSAT-UK Colloquium and the AMSAT-NA Symposium. The meeting included a discussion concerning a change in IARU policy concerning frequency coordination in two meter band for satellites licensed by the FCC as "Experimental" rather than "Amateur Satellite Service." Effective 1 JUL 14, the IARU will no longer coordinate frequencies for experimental satellites in the Amateur Satellite Service two meter band. In addition, Hans outlined the coordination challenges of the upcoming European 'QB50' fleet of 50 cubesats that are currently under development and planned for launch in Spring 2015.

There were also two tours scheduled in conjunction with the Symposium:

USS Texas (BB-35) tour on Sunday morning. The Texas is the only surviving US naval vessel that served in both World War I and World War II that still exists. Those that took the tour were able to view the ship from stem to stern, including seeing the original radio rooms as well as the current amateur radio station on board the vessel, W5VID. Certainly a highlight for me was climbing into the #2 turret and seeing how the 14" guns were loaded and fired.

Johnson Space Center (JSC) tour on Monday morning, 4 NOV. Our bus left the hotel at 0800 and we proceeded to the Neutral Buoyancy Lab. Other stops included the Mockup Building (where 1:1 size replicas of the ISS modules are used to train astronauts) and the Mission Control Building where we viewed the current operations of the International Space Station. While the group sat in the visitor's gallery, our own Frank Bauer, KA3HDO was "on the floor" being interviewed by JSC PAO Kelly Humphries regarding the AMSAT Symposium and the role of amateur radio on the International Space Station. We also had the opportunity to tour the preserved Mission Control that was used for the historic Apollo and other flights and visited JSC Amateur Radio Club W5RRR which was involved in a number of Shuttle amateur radio activities and continues today as an active club.

Each Symposium is unique, and this year's event was certainly a highlight both with regard to the quality of presentations and AMSAT activities (such as the banquet panel) as well as the special tours that were provided. I certainly did not hear a negative comment from anyone who came to Houston.

We have already announced that the 2014 AMSAT Space Symposium will take place in the Baltimore-Washington area as it will be AMSAT's 45th anniversary. Frank Bauer, KA3HDO has agreed to serve as the host committee chair. We have not yet selected a hotel or confirmed any dates; those will be announced in early 2014 once arrangements are finalized.

"Upcoming Amateur Radio Satellites: The Flood has Arrived"

That's the title of one of the Proceedings papers, written by Bryan Klofas, KF6ZEO. As he presented his paper on Friday afternoon, 1 NOV, it became very clear to me that there are LOTS of cubesats being built with many of them occupying frequencies in the Amateur Satellite Service bands. Indeed, November saw two significant launches, one from Wallops Island, VA and the other from Russia. Included in the mixture of launched satellites is FUNcube-1, now designated OSCAR-73. Congratulations to both AMSAT-UK and AMSAT-NL for the successful deployment and initial operation of this educational and amateur radio satellite.

There is plenty of information available about these new birds, so there is no need to go into the technical details in this column. I do want to note the variety of satellites that are now available to amateurs, covering both two-way communications as well as telemetry collection and forwarding. AMSAT-UK has developed a 'dashboard' designed for schools and amateurs to collect data about the AO-73 satellite and the experiment that is on board the spacecraft. The University of Florida, Gainesville "Swampsat" satellite has a packet radio data transmission from their satellite; the Gator Amateur Radio Club and the University of Florida Small Satellite Design Club are asking for amateurs to forward collected telemetry to them. Details may be found in ANS-328. Given the variety of capabilities and number of these platforms, there are plenty of new satellites to pique our interests. Please take the time to become familiar with these recent developments and if you're able to assist with telemetry collection and forwarding, please help out.

Overall, 10 amateur radio satellites were deployed this past week as part of the "cloud" that was deployed. Very impressive!

continued on page 25 ...



Richard Siff, W4BUE
richard.siff@verizon.net

The K4AMG Amateur Memorial Radio Club is a nonprofit organization of volunteers who mentor youth by providing STEM skills in electronics and wireless communications in the Chesapeake Public Schools. Our goal is to have students take STEM skills from the school to home, backyard, and work. We also encourage students to consider the many good paying and rewarding careers in electronics and wireless communications. Our goal is to encourage students to achieve and to succeed in these highly technical skills.

The club mentors youth in the public schools in Chesapeake, Virginia. This year the K4AMG club reached out to over 200 science and technology teachers during an in-service day meeting with a presentation on CubeSat technology. The club demonstrated how electronics, wireless communications and amateur radio is a great fit into the STEM (Science, Technology, Engineering, and Math) programs.

The K4AMG club has recently completed a program using the AMSAT CubeSat simulators and presented it to the following:

- * STEM technology teachers Chesapeake Schools
- * Western Tidewater Amateur Radio Club
- * Society of Broadcast Engineers Chapter 54 at the WHRO Studios
- * Virginia Beach Amateur Radio Club
- * Virginia Beach Hamfest Forum and Table
- * Chesapeake Center for Science and Technology High School (CCST)

Barry Priddy, K5VIP, demonstrated CubeSat monitoring capabilities and Rich Siff, W4BUE, showed video clips of motivated high school students from the Dayton Hamvention Youth forums hosted by Carole Perry, WB2MGP. At the Dayton Youth forum, Carole talked about how students talked to the astronauts on the International Space Station and how this experience motivates them into technical skills. This motivated our club to assemble our portable satellite station.

They also used their new Kenwood TS-2000 purchased with the grant from ARRL. The radio will be used by the students at the CCST. On May 24th students at the CCST assembled the antennas and made their first satellite QSOs using the school call sign, W4FOS. CCST also sponsors an FM station, WFOS, whose classroom hosted a hands-on activity allowing the students to examine a



(top) Chris Hanslits, W4VX, and the CubeSat Emulator.

(above) Duane Ettwein, KJ4YKG, demos OSCAR communications at a SAT COM picnic sponsored by the K4AMG Club.

(below) The K4AMG club's portable OSCAR station which is available to local clubs for schools and special events.

CubeSat directly.

CubeSat presentations were also made at Chapter 119 QCWA by Priddy, the Western Tidewater Amateur Radio Club and the Virginia Beach Hamfest by Chris Hanslits, W4VX; the Virginia Beach Amateur Radio Club by Edwin Williams; the Society of Broadcast Engineers Chapter 54 by Siff.

The K4AMG Amateur Memorial Radio Club was named for Bob Siff, K4AMG. Bob, licensed as a teenager, was one of the founders of the Dayton Hamvention. His original callsign was W8QDI. Bob graduated from Purdue University and later moved to Sarasota, Florida, where he worked in marine electronics. When he moved to Sarasota, the FCC issued him K4AMG. In addition to amateur radio, he was an active member of the Sarasota Power Boat Squadron.

The club's website can be accessed at
<http://www.k4amg.org>.



Bill Ress, N6GHZ
n6ghz@amsat.org

This article describes testing that was performed on three DVB-S receivers costing less than \$32 that can be used to receive the HAMTV signal from the International Space Station (ISS).

Now that the HAMTV video transmitter has been successfully launched to the ISS and is waiting commissioning, the attention is now focused on the equipment needed by Amateurs to receive this new Amateur digital TV signal from space. One key component is the DVB-S receiver. The receiver needs to receive and demodulate the DVB-S QPSK signal format (data rate) of 1.3 MegaSamples/second (Ms/s) with a forward error correction (FEC) of $\frac{1}{2}$.

The DVB-S QPSK signal format is also used by the free-to-air (FTA) satellite signals currently transmitted from several Ku band geostationary satellites. The direct-to-home (DTH) satellite industry has spawned many receivers available throughout the web. Most of the receivers have specified receive modulation capabilities of 2 to 45 Ms/s. This leads to the question whether they will work at 1.3 Ms/s. By the way 1.3 Ms/s was chosen because it has a narrower bandwidth of approximately 1.4 MHz compared to higher data rates which have higher signal bandwidths. So the key criteria for choosing a receiver is will it lock onto (receive) the data rate from HAMTV at 1.3 Ms/s?

In addition to determining if the receiver you chose from the many options out there receives the HAMTV data rate, you also need to determine the form factor for your choice. There are three:

- USB
- Plug-in PC cards (none exist for the Mac - to my knowledge)
- Standalone.

For testing, I chose a USB and a standalone receiver purchased on eBay and the legacy high end receiver I have been using for years for my FTA receiving.

Why not evaluate a DVB-S PC plug-in card receiver?

While there are several good ones on the market, they tend to be \$80 and higher, and frankly I'm cheap. Additionally they require that you get into your PC, install the card and then the software/drivers. For many (me included) this can become frustrating if it

doesn't go right, and also as noted above, they exclude the Mac user.

A word about the DVB-S receiver testing

One of the problems that will be encountered is testing the HAMTV receiving setup in the absence of the HAMTV signal from the ISS. A low cost 2.4 GHz QPSK test source doesn't currently exist. I was fortunate to borrow the expensive 2.4 GHz, 1.3 Ms/s test source built by Kerry Banke, N6IZW. This uses the Digilite PCB, a PLL up converter to 2.4 GHz and a video test pattern.

Using a DVB-S receiver intended for the FTA applications for HAMTV at 2.4 GHz

All FTA/DTH DVB-S receivers are designed to work with a Ku band satellite block down converter (Low Noise Block - LNB). The LNB converts the Ku band satellite signal (11.7 to 12.2 GHz) to a frequency in the 950 to 2150 MHz (L band) region. This is the input frequency for the DVB-S receivers. So, when configuring your receiver, you need to know the L band IF frequency of your 2.4 GHz down converter. You should note that HAMTV can transmit on one of four possible frequencies. We will use 2.422 GHz in our example. Some 2.4 GHz converters on the market, using a 916.5 MHz Local Oscillator, (such as those made by Kuhne and High Sierra Microwave) will output the 2.422 GHz HAMTV signal at 1.5055 GHz. Your DVB-S receiver is configured, using its software, to receive a signal from the "phantom" Ku band LNB at 1.5055 GHz.

An example would be to configure the DVB-S receiver to be working with a Ku band LNB that uses a 10.6 GHz LO. The Ku band satellite transponder that would give you an L band output of 1.5055 GHz would have a frequency of 12.1055 GHz. This frequency is used for configuring the system when setting up the receiver software. The software will also allow you to input the modulation which, for HAMTV, is 1.3 Ms/s with a FEC of $\frac{1}{2}$. Each receiver will accomplish this differently depending on the software it uses. Since the Banke HAMTV test source outputs a 2.400 GHz signal, the L band IF output for the 2.4 GHz down converter used is 1.4835 GHz since the down converter I used in the tests had an LO at

916.5 MHz.

The USB DVB-S Receiver Tested

This receiver is available from several eBay vendors for around \$32. Some offer free or low cost shipping. Just search "DVB-S USB TV Receiver" in the eBay "Satellite TV Receivers" category. Like all receivers in this category, it is intended for the FTA/DTH satellite market.



USB DVB-S Receiver

The receiver was run from my Dell notebook using Windows 7. It comes with a version of BlazeDTV 6.0 software which is used to control the receiver. This software can also capture an image or record the streaming video. Software/driver installation was uneventful. I used the "phantom" Ku band setup described above to enable the receiver to work with the 2.4 GHz down converter's IF output.

This USB receiver will allow completely portable operation since it is run by the computer and the USB DVB-S receiver can also provide power to the 2.4 GHz down converter. This power would be 13 to 18 volts (on its LNB port), assuming the down converter draws less than 400 mA. This is the configuration I prefer.

The test results looked good. The specification for this receiver is for a minimum signal of -65 dBm and a minimum data rate of 2Ms/s. Using the Banke HAMTV 2.4 GHz test source, this receiver, however, locked onto the L band IF signal around -70 dBm. The 2.4 GHz down converter I used (made by High Sierra Microwave) had a 40 dB conversion gain, making the signal -110 dBm at 2.4 GHz.

The Standalone DVB-S Receiver

This category of receiver requires connection to the AC mains and outputs the video/audio signal to a separate monitor, but does not require a PC to just view the HAMTV signal. To capture HAMTV video, it will require a piece of hardware/software like the USB EasyCAP connected in place of the monitor to record the video/audio on the PC or Mac. The receiver I obtained on eBay was the X2-FTA DVB-S Mini Digital Satellite Receiver available for around \$24.00 and free shipping.



X2-FTA DVB-S Mini Digital Satellite Receiver

The setup/control software for the receiver is internal firmware, and using an external monitor, setup went without issues. I also installed the USB EasyCAP in place of the monitor and ran the HAMTV video to my



Viewsat VS2000 ULTRA Receiver

PC where it was captured and stored. RF testing was done the same way as with the USB receiver. This receiver also provided an L band sensitivity of approximately -70 dBm and locked to the 1.3 Ms/s HAMTV signal without issues even though it also has a minimum data rate specification of 2 Ms/s.

The Legacy Standalone FTA Receivers

For years I have been using a full featured FTA receiver, the Viewsat VS2000 Ultra, in my FTA satellite setup. Since it was produced some years back, I wondered how it would configure and perform for HAMTV. These receivers, and many like it, are often available used on eBay at very attractive prices. At the time of this writing, several of these models were available for under \$20 on eBay.

Again, using the 2.4 GHz HAMTV test source, it locked to the 1.3 Ms/s signal at just under -65 dBm and the internal setup software allowed the required “phantom” transponder and HAMTV modulation to be configured.

Summary

Receiving the HAMTV signal from the ISS will provide the Amateur with interesting new technical challenges. For many, it will be their introduction to Amateur digital TV, a format being used on more and more “TV repeaters” throughout the world. Tracking the fast moving ISS with a 2.4 GHz antenna will also provide challenges. So with this brief introduction to your “low cost” DVB-S receiver options, your receiver choice might be made easier, allowing you to concentrate on the other blocks needed in your HAMTV receiving system.



November 2013 NASA ELaNa Minotaur Launch Satellite Summary		
Satellite	Sponsor/Owner Institution	Downlink Frequency (MHz)
Black Knight-1	United States Military Academy	437.345
CAPE-2	Cajun Advanced Picosatellite Experiment	145.825; 437.325
ChargerSat-1	University of Alabama in Huntsville	437.405
COPPER	Saint Louis University Parks College	437.290 9600bps
CSIP	Technology Cubesat	
DragonSat-1	Drexel University	145.870
Firefly	Goddard Space Flight Center	
Ho'oponopono-2	University of Hawaii at Manoa	427.220 9600bps FSK/GMSK
KYSat-2	Kentucky Space LLC	437.405
Lunar Orbiter/ Lander CubeSat	University of Vermont Vermont Technical College	
NPS-SCAT	Naval Postgraduate School	2401.200 - 2447.600; 437.525
ORSES	US Army Space and Missile Defense Command	
ORS Tech-1,2	Johns Hopkins University	
ORS-3	United States Air Force	
PhoneSat-v2	NASA Ames Research Center	2401.200 - 2431.200; 437.425
Prometheus-1,2,3,4	Los Alamos National Laboratories	
Rampart	Morehead State University	
SENSE-1,2	United States Air Force	
STARE-B	Lawrence Livermore National Laboratories	
STPSat-3	USAF Space Test Program	
SwampSat	Gator Amateur Radio Club University of Florida	437.385
TetherSat-1,2	Naval Research Laboratory	(1) 437.100 (2) 437.305 9600bps AX.25
TJ3Sat	Thomas Jefferson High School	437.320
Trailblazer-1	University of New Mexico	437.425
Vermont Lunar Cubesat	Vermont Technical College	437.305 9600bps

Note: Refer to JE9PEL's web page for additional mission information: <http://www.ne.jp/asahi/hamradio/je9pel/minotaur.htm>



AMSAT members attended the HAM-COM Convention in Plano, Texas in June 2013. Here are photos of the AMSAT table, live satellite demonstrations, the AMSAT Forum, and a balloon flight by the Texas Balloon Launch Team.



Keith Pugh W5IU and Douglas Quagliana KA2UPW at the AMSAT booth during the 2013 Plano, Texas HAM-COM on June 7th. The display featured a satellite tracking display, AMSAT books for sale, membership recruiting, and practical advice about amateur satellite operations. Contact Martha at the AMSAT Office for a hamfest kit to be shipped to you for your next public relations appearance. (W5ACM photo)



Douglas, KA2UPW and Keith W5IU work the radios and coordinate activities while interested HAM-COM participants do the talking and antenna pointing during a demo satellite pass at the Plano Convention Center. (W5ACM photo)



Keith Pugh W5IU making satellite contacts with his pair of Yaesu FT-817s at the Plano, Texas HAMCOM, June 7, 2013, while Douglas Quagliana, KA2UPW and Ken Talkington AE5LB aim the UHF and VHF antennas. (W5ACM photo)



Keith Pugh W5IU making satellite contacts with his Yaesu FT-817 at the Plano, Texas HAMCOM, June 7, 2013, while Ken Talkington AE5LB and Douglas Quagliana, KA2UPW check pass data and keep the antenna properly aimed. (W5ACM photo)



(above, left) Douglas Quagliana KA2UPW explains what it takes to make satellite contacts during one of the AMSAT forums at the 2013 Plano, Texas HAM-COM.

(above, right) Thomas Krahn KT5TK gets ready to launch a balloon (South Texas Balloon Launch Team) complete with a micro APRS beacon on two meters during a lull in the action at the 2013 Plano, Texas HAM-COM. The flight from Plano was BLT-33.4

(left) Thomas KT5TK does a little shade-tree monitoring of the South Texas Balloon Launch Team flight. Two-meter APRS data with telemetry could easily be heard on radios, or just tracked on-line via aprs.fi. (W5ACM photos)



Hamsat operators George Carr, WA5KBH; Jack Wilson, KF5LOQ; Andy Mac Allister, W5ACM; and Clayton Coleman, W5PFG spend a bit of time eyeballing (and scouring) in the HamCom flea market area before the sun gets too far overhead. (WA5KBH photo)





AMSAT was represented at the 2013 Central States VHF Conference in Elk Grove Village, Illinois. Keith Pugh, W5IU presented an AMSAT/ARISS update on Saturday Morning. Keith and John Spasojevich, AG9D worked some passes out in the parking lot area known as Rover Row and the Dish Bowl ... trying to convince these terrestrial guys to try elevation on their antennas!

The AMSAT table had information about Fox-1 and the upcoming HAM-TV system for ARISS. Other AMSAT members attending included Bill Tynan, W3XO; Tom Clark, W3IO; and Rick Hambly, W2GPS. Joel Harrison former ARRL President and current CEO David Sumner were in attendance also with David being the banquet speaker.



Keith, W5IU (right), and Kent Britain, WA5JVB (left), demonstrate amateur radio satellite communications at the Austin Summerfest August 3, 2013. The antennas used for the demos are the "Cheap Yagi" antennas designed by Kent. (KA2UPW photo)



AMSAT was represented at the Dallas Frontiers of Flight Museum Moon Day event on July 20. Phil Robinson, KB5ASY, Keith Pugh, W5IU, and Chris Brewer, N5GMJ at the AMSAT table. KB5ASY and W5IU also demonstrated amateur radio satellite communications. Photo by KF5ECX, Suzanne Robinson.

AMSAT VP Human Space Flight, Frank Bauer, KA3HDO Interviewed on NASA TV



We were able to watch live on monitors in the Visitor Gallery in Mission Control. KB1SF photos.

AMSAT Vice President Human Space Flight, Frank Bauer, KA3HDO was interviewed on NASA TV during the Symposium tour of Mission Control at JSC. Frank was interviewed by Public Affairs Officer Kelly Humphries about amateur radio satellites and the ARISS program.

The interview can be seen on YouTube at: <http://tinyurl.com/KA3HDO-Interview>



Frank seated in Mission Control during the interview. NASA TV gave us the perfect opportunity to publicize Amateur Radio in Space and report on the impact of the ARISS program in STEM education initiatives.



Watch for a full report of the AMSAT 2013 Space Symposium and JSC tour in the January/February 2014 AMSAT Journal.

AMSAT is the North American distributor of **SatPC32**, a tracking program designed for ham satellite applications. For Windows 95, 98, NT, ME, 2000, XP, Vista, Windows 7.

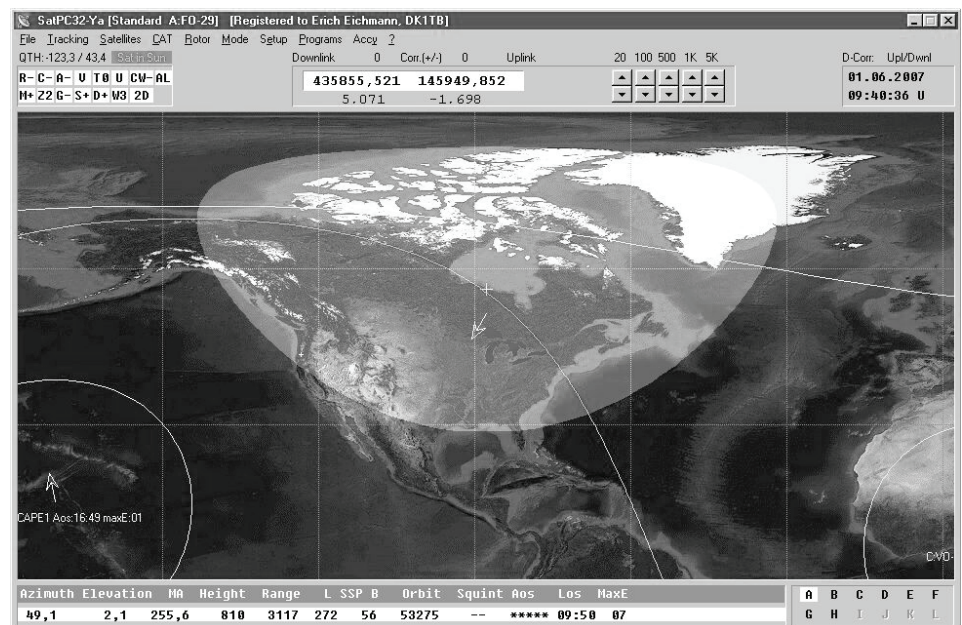
Version 12.8b is compatible with Windows 7 and features enhanced support for tuning multiple radios.

Version 12.8b features:

- SatPC32, SatPC32ISS, Wisat32 and SuM now support rotor control of the M2 RC-2800 rotor system.
- The CAT control functions of SatPC32, SatPC32ISS and Wisat32 have been expanded. The programs now provide CAT control of the new Icom transceiver IC-9100.
- The main windows of SatPC32 and SatPC32ISS have been slightly changed to make them clearer. With window size W3 the world map can be stretched (only SatPC32).
- The accuracy of the rotor positions can now be adjusted for the particular rotor controller. SatPC32 therefore can output the rotor positions with 0, 1 or 2 decimals. Corrections of the antenna positions can automatically be saved. In previous versions that had to be done manually.
- The tool 'DataBackup' has been added. The tool allows users to save the SatPC32 program data via mouse click and to restore them if necessary. After the program has been configured for the user's equipment the settings should be saved with 'DataBackup'. If problems occur later, the program can easily restore the working configuration.
- The rotor interfaces IF-100, FODTrack, RifPC and KCT require the kernel driver IOPort.SYS to be installed. Since it is a 32-bit driver it will not work on 64-bit Windows systems. On such systems the driver can cause error messages. To prevent such messages the driver can now optionally be deactivated.
- SuM now outputs a DDE string with azimuth and elevation, that can be evaluated by client programs. Some demo files show how to program and configure the client.

Minimum Donation is \$45 for AMSAT members, \$50 for non-members, on CD-ROM. A demo version may be downloaded from <http://www.dk1tb.de/indexeng.htm>. A registration password for the demo version may be obtained for a minimum donation of \$40 for members and \$45 for non-members. Order by calling 1-888-322-6728.

The author DK1TB donated SatPC32 to AMSAT. All proceeds support AMSAT.



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This is the first of a four part series of articles which aims to introduce the Fox-2 Maximum Power Point Tracker, (MPPT), to AMSAT members. Fox-2 is a 3U Cubesat which will be the successor to the Fox-1 family of satellites. This upgraded satellite will incorporate seven solar cells on each of its four sides producing up to 9.12 Watts of power per panel. The MPPT that has been designed for Fox-1 is not rated to handle this much power with the hardware used, forcing a completely new design to be implemented. AMSAT sponsored four students at the Rochester Institute of Technology (RIT) in Rochester, NY during a two-quarter senior design project lasting twenty weeks as part of the Kate Gleason College of Engineering (KGCOE) multidisciplinary senior design program to design the Fox-2 MPPT. These four electrical engineering students were Brenton Salmi, KB1LQD, Bryce Salmi, KB1LQC, Ian MacKenzie, KB3OCF, and Daniel Corriero who are shown in Figure 1. Our group considers itself privileged to have worked with AMSAT through Tony Monteiro, AA2TX, on this large undertaking. It was a rewarding and educational experience none of us will forget and from which all of us have gained crucial hands-on experience.



Figure 1: Fox-2 MPPT Design Team (left to right) Ian MacKenzie, KB3OCF; Brenton Salmi, KB1LQD; Bryce Salmi, KB1LQC; and Daniel Corriero

This series will cover the following topics:

- Part 1: Maximum Power Point Tracking Basics, Customer Needs, and Requirements
- Part 2: Analog Maximum Power Point Tracking and Circuit Protection
- Part 3: Health and Status Telemetry System
- Part 4: Test Results and conclusion

Maximum Power Point Tracking

Solar panels are both simple in operation but complex to connect to. Those of you who have used a solar panel have likely attached a battery or device to it and obtained power from the sun. However, it's unlikely that the maximum power from the panel was being produced by this setup, even in direct sunlight. This is because solar cells

produce their maximum power at a specific operating voltage called the maximum power point voltage or the MPPV as shown in Figure 2. The upper line of the graph is the I-V curve of the example solar cell in which the x-axis is the voltage of the solar cell and the y-axis is the current. As can be seen, when the solar cell is operating in a short circuit, the current is maximum but the voltage is zero. This means no power is delivered to the payload. Similarly, when the solar cell is operated in an open circuit, the maximum voltage is generated but no current is delivered to the payload. Again, this results in no power being delivered to the payload. The lower line of the graph shows the power curve of the solar cell in which the x-axis is the voltage and the y-axis is the power delivered to the payload. Forcing the solar panel to operate at the maximum power point (MPP) will extract the maximum amount of power from the panel. On Figure 2, this point is located just to the left of the knee of the I-V curve at the point where it crosses the dashed vertical line.

Maximum Power Point Voltage Variance

The MPPV varies with solar irradiance (i.e. solar radiation intensity, given in W/m^2) as well as with the temperature of the solar cells. As shown in Figure 3, the intensity of the light hitting a solar cell generates a current which varies with respect to the cell's voltage. However, the MPPV of the I-V curve, which is generally located close to the knee, does not move left or right much which means that the MPPV stays in roughly the same spot. Now, in Figure 4, the intensity of the light hitting the example solar cell was held constant while the temperature was varied. The "knee" moves drastically left and right indicating that the MPPV has shifted with temperature. If the small percentage of power that is lost by not tracking the MPP with the changing light intensity can be deemed acceptable, then tracking the MPPT due to the temperature change simplifies the solution. This still maximizes a large majority of the power that would otherwise be lost.

Implementing Solar Panels

There are four common methods to implement solar panels on small spacecraft such as Cubesats. These methods include direct energy transfer and three MPPT algorithms (constant voltage, maximum current, and perturb and observe). Any MPPT method that is implemented should be designed efficiently so as to provide more power than by directly connecting the solar panel to the battery through direct energy transfer. If a method of MPPT is inefficiently designed, it can harm the satellite's operational capabilities and should not be implemented. MPPTs are usually designed with a DC/DC converter to provide an impedance match between the high impedance of the solar panel to the low impedance of the payload. Treating an MPPT as a method of impedance matching can help visualize what it is doing in order to maximize power.

Direct Energy Transfer

Direct energy transfer (DET) is an extremely simple method of implementing solar panels and can be found on many simple satellites. DET is accomplished by directly connecting the spacecraft battery to the solar panels and thus the voltage of the battery determines the operating voltage of the solar panel. If the nominal battery voltage is designed to be close to the maximum power point voltage of the solar panel, the system will generally be efficient. It will not track the maximum power point voltage as it shifts with irradiance and temperature however. Additionally, if the battery short-circuits, the panels will produce almost no power. This renders the satellite inoperable unless the battery is designed to disconnect from the solar panels in the event of a failure.

Constant Voltage

An extremely simple method of MPPT is implemented by assuming that the maximum power point voltage of the panel corresponds to 76% of the open circuit voltage of the solar panel. The calculated operating voltage shifts with irradiance and temperature change. A DC/DC switching converter is used to force the solar panel to operate at this voltage. It does this by varying the pulse width modulation in order to conduct the correct amount of current into the payload. The panel voltage then changes accordingly. While 76% of open circuit voltage is an estimated value, this method

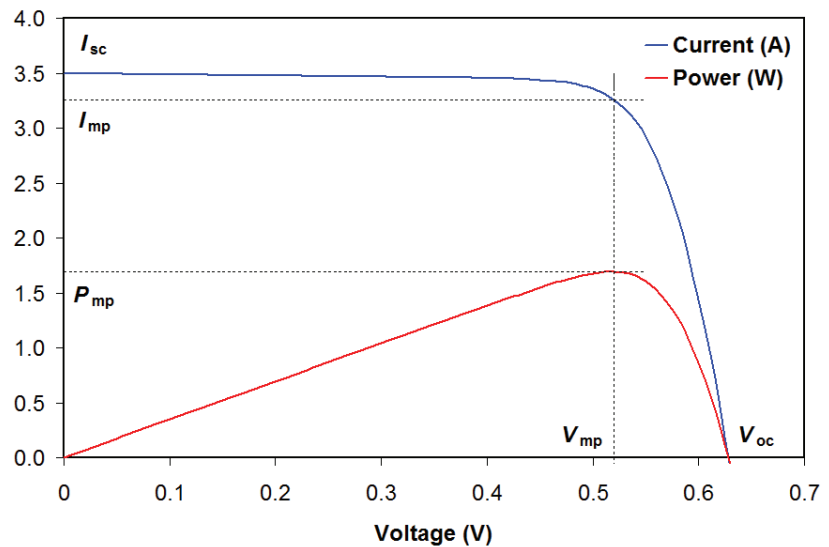


Figure 2: An example solar panel current - voltage (I-V) curve and associated power curve. The top line is the I-V curve and the lower line is the power extracted from the solar panel. Notice that at the V_{mp} the maximum power is produced. [1]

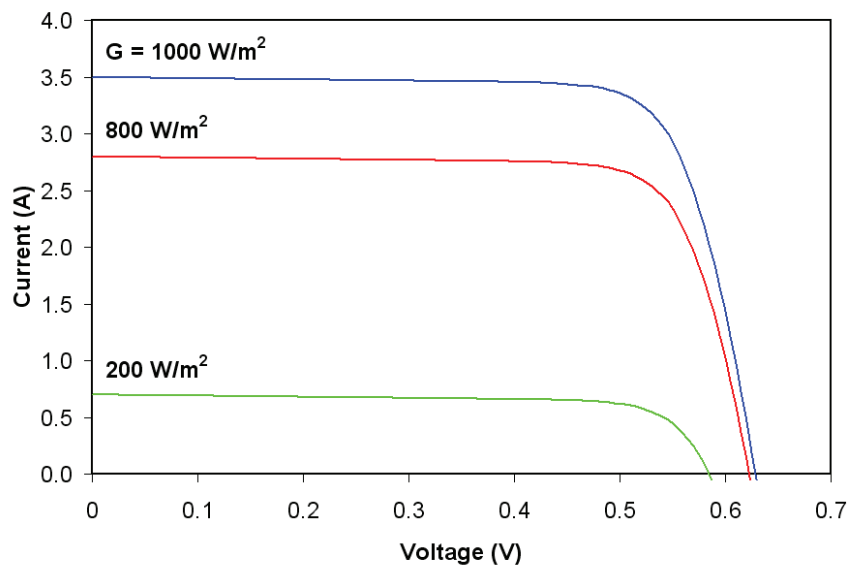


Figure 3: The I-V curve of an example solar panel with constant temperature as solar intensity is varied. Notice that the "knee" of the curve is relatively static over varying solar intensity. [1]

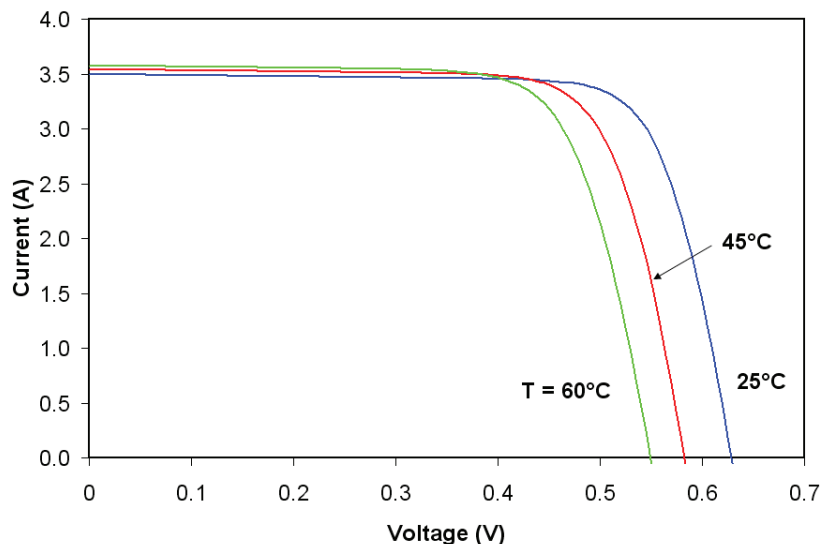


Figure 4: The I-V curve of an example solar panel with constant solar intensity as the temperature is varied. Notice that the "knee" of the curve varies widely over temperature. [1]

also requires the payload to periodically be disconnected from the solar panels to measure the open circuit voltage, limiting the possible efficiency of this method.

Maximum Current

One method that is ideal for short duration Cubesat missions (about six months duration) is the maximum current method. A DC/DC converter is placed between the solar panel and the battery such that the battery determines the DC/DC converters output voltage since it's on the same voltage node. Since the battery voltage changes slowly with respect to the switching frequency of the converter, the converter's output voltage can be assumed to be nearly constant. Pulse width modulation can be used to change the panel voltage. This maximizes the current into the battery and will provide maximum power. This eliminates the need for a microprocessor to compute power by measuring the current and voltage. Since voltage is constant, maximum power correlates to maximum current. However, since the battery is required for this method of MPPT, it is not suitable for Fox-2 due to the need for the MPPT to operate without the presence of a battery.

Perturb & Observe

The perturb and observe method of MPPT is commonly used and often implemented with a microcontroller in commercial systems. The microcontroller controls a DC/DC converter and also monitors the power produced by the solar panel. A small change in panel voltage, or perturbation, is applied by means of an increase or decrease in panel voltage. The DC/DC switching converter is driven again with pulse-width modulation to vary the current from the solar panel. This, in turn, varies the solar panel voltage over the I-V curve. The computed power that is then obtained determines the direction of the next perturbation. If the power increases, a perturbation in the same direction is applied, if the power decreases, a perturbation of the opposite direction is applied to the solar panel. The perturb and observe method never operates directly at the MPP since it will, at best, oscillate around the MPPV under normal operation. However, the algorithm must be prevented from tracking on a local maximum on the power curve. As well, it must be prevented from accidentally tracking in the wrong direction in fast-changing illumination conditions, such as when the spacecraft is spinning.

Also, the implementation of a microcontroller means that this solution is likely more susceptible to radiation effects than others methods which are not implemented with discrete digital states.

Fox-2 Maximum Power Point Tracking Algorithm

The Fox-2 maximum power point algorithm is based on the assumption that the MPPV changes more significantly due to temperature effects than due to variations in illumination. The algorithm is completely analog and implemented with operational amplifiers and a pulse-width modulator (PWM) integrated circuit. An analog MPPT is generally more tolerant to radiation events such as single event effects (SEE), and total ionizing dose (TID). This robustness will allow the spacecraft to operate for its projected five-year lifetime.

Figure 5 shows the block diagram of the circuit delivered to AMSAT. All blocks inside the dashed box were within the Fox-2 MPPT project scope. The DC/DC converter is a buck converter that is controlled by the PWM MPPT feedback control circuitry. This control circuitry obtained solar panel

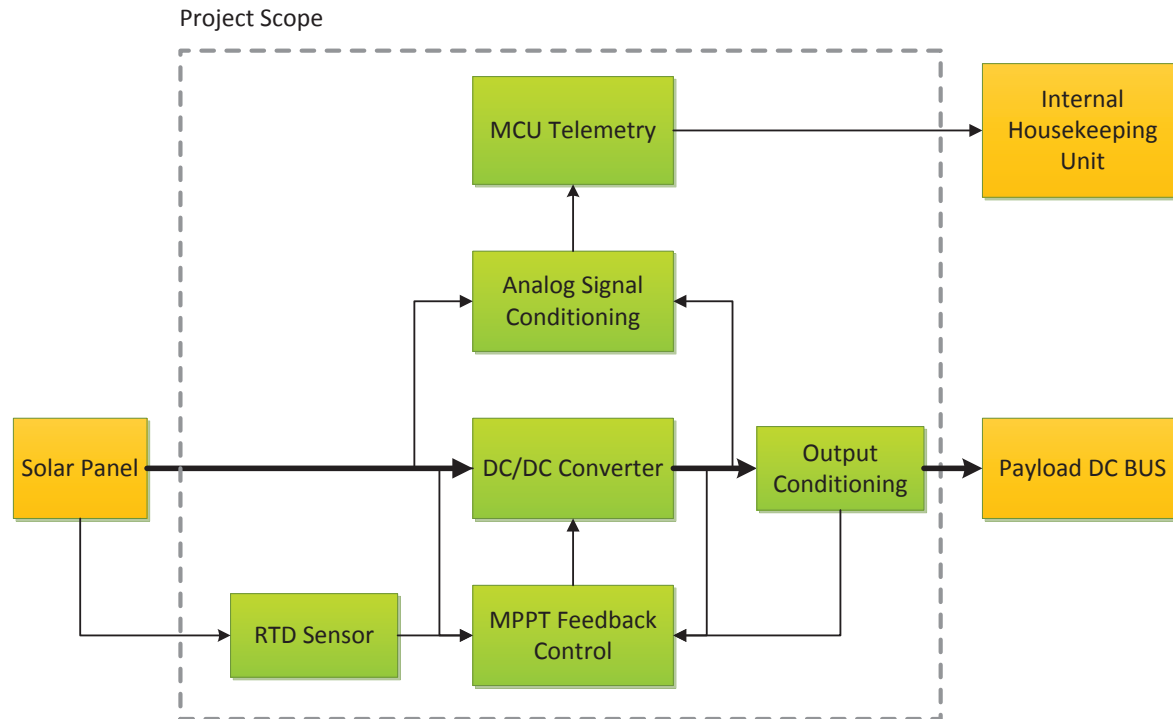


Figure 5: The AMSAT Fox-2 Maximum Power Point Tracker high-level block diagram. All blocks within the dashed box were within the scope of our project.

High-Level MPPT Diagram

4-29-2013

voltage and temperature measurements used to maximize power. Additionally, safety circuitry allowed the output voltage to be monitored and conditioned. Analog measurements were conditioned and sampled with an analog-to-digital converter (ADC) using a Texas Instruments MSP430 microcontroller. This microcontroller produced telemetry data for the Fox-2 Internal Housekeeping Unit (IHU).

Maximum power is produced by predicting the MPPV using an accurate temperature measurement of the solar panel from a resistive temperature detector (RTD). Using a solar panel comprised of known solar cells, such as the Spectrolab UTJ cells, analog circuitry can accurately predict the correct operating voltage for maximum power transfer. By keeping losses in the DC/DC converter as low as possible, a net gain in power over direct energy transfer is obtained since tracking of the maximum power point voltage over temperature occurs. The Fox-2 MPPT algorithm and physical implementation will be more thoroughly explored in the second installment of this series of articles.

Fox-2 MPPT Customer Needs

Customer needs cover general project objectives that had to be achieved by the circuit delivered to AMSAT. Figure 6 details the needs specified by AMSAT which our team strived to meet. These needs were organized in order of importance ranging from “must have” to “preference”. The top three needs for the Fox-2 design include maximizing the energy transfer between the solar panel and the payload, meeting all environmental requirements, and providing a limited output voltage so as to not damage the payload.

If the energy transfer through the MPPT DC/DC converter is inefficient, the benefits of an MPPT are quickly erased and DET becomes a better alternative. Additionally, the satellite will experience harsh temperatures in the vacuum of space where only conduction and radiation are the methods of heat transfer. Temperature variations occur multiple times per day due to the orbit. This results in both electrical and mechanical stresses on the components which have to be accounted for. The electrical stresses can result in changes in the component operating characteristics while the mechanical stresses could lead to cracking.

Fox-2 MPPT Engineering Specifications

The design of the Fox-2 MPPT, and the hardware which was built and delivered to AMSAT, had to meet a specific set of requirements. Every specification required a test to prove that it was satisfied. The specifications shown in Figure 7 were carefully determined through several meetings with Tony Monteiro over the phone and email. Specifications which were hard to test by the senior design group, such as the radiation specification, were achieved by providing analysis and documentation. This presented a level of assurance that the specification was indeed met with a certain amount of confidence regarding the radiation susceptibility of the design. Overall, the specifications have been listed in order of importance with a different scaling from the customer needs document due to RIT documentation requirements.

Some of the specifications should be mentioned in detail as they are not clearly presented in Figure 7. The power produced by each panel is in fact 9.12 W when the solar panel is cold and operating in full sunlight. This occurs immediately following an eclipse when the satellite is extremely cold but also fully illuminated and before any substantial heating from the sun has been received. The specification of 7.24 W was an error which was eventually corrected and the required 9.12 W was tested on the physical MPPT. The output voltage of the MPPT will be covered in more detail in the second installment of this series. Overall, the output voltage is not regulated but is, rather, limited. At no point should the output voltage of the MPPT nominally operate above 4.1 V. Any voltage below this is generally acceptable down to about 3.3 V. During operation, the output voltage will only ever deviate from 4.1 V when more power is requested from the solar panel than it can provide at the MPP. When this occurs, the MPPT circuitry will track the predicted MPPV to continue providing maximum power to the payload in varying load conditions. As the current demand from the payload increases, the output voltage must drop due to conservation of energy in order to maintain the maximum power available from the solar panel. The circuit was also tested to -40° C and +85° C operating temperatures since the circuit boards inside the satellite are protected from direct exposure to the sun and black of space. The solar panels, however, are exposed and will

experience -60° C to +60° C temperatures which the MPPT must account for in its operating voltage calculation. Lastly, an important specification that drove the design was the requirement to design a circuit in which at least four MPPT devices could fit into the area of one Cubesat circuit board.

Final Thoughts

We hope you enjoyed the technical dive into the world of satellite design. This has been an extremely educational and rewarding project. Having the opportunity to share the design and some of our knowledge is quite a privilege. The next AMSAT Journal will present into the schematics and theory of operation for the Fox-2 MPPT. We're sure many of you are eager to learn about the design of the circuit. If you want to skip ahead and read more about this project we invite you to visit the RIT EDGE website where our project has been documented on by visiting:

<http://edge.rit.edu/edge/P13271/public/Home>

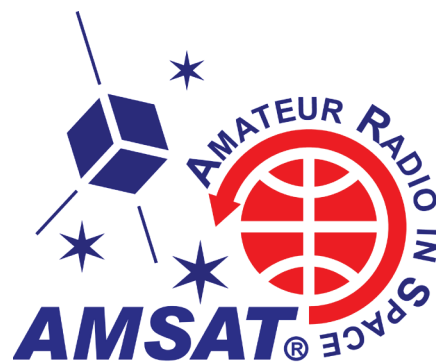
Thank you for reading about our senior design project.

References and Attributions

[1] Figures 1,2, and 3 attribution: By Squirmymcphree (Own work) [CC-BY-SA-3.0 (<http://creativecommons.org/licenses/by-sa/3.0>) or GFDL (<http://www.gnu.org/copyleft/fdl.html>)], via Wikimedia Commons



(continued page 16 ...)



Project: **P13271 AMSAT Maximum Power Point Tracker**
Revision #: 2 Date: 4/29/2013

Customer Need #	Importance	Description	Comments/Status
CN1	1	Maximize energy transfer between solar panel and load	Efficiency
CN2	1	Meet environmental requirements	Temperature, Radiation
CN3	1	Provide limited output voltage	Customer supplied upper limit
CN4	2	Meet mechanical constraints	Component size and form factor
CN5	2	Communicate status information with satellite IHU	Health and status information
CN6	2	Recover from soft errors in software	Watchdog

IHU Internal Housekeeping Unit

Importance Rating Scale

Must have 1
Nice to have 2
Preference 3

Figure 6. Customer needs specified by AMSAT Engineering, organized by importance ranging from “must have” to “preference”.

Project: **P13271 AMSAT Maximum Power Point Tracker**
Revision #: 2 Date: 5/5/2013

Spec. #	Importance	Source	Function	Specification (metric)	Unit of Measure	Marginal Value	Ideal Value	Comments/Status
S1	9	AMSAT	CN1,CN3	Maximum Power Input	Watts	7.24	>7.24	27 cm^2 cells, Qty=7
S2	9	AMSAT	CN1	Input Voltage Max	Voltage	22	>22	NASA Derating
S3	9	AMSAT	CN3	Limited Output Voltage	Voltage	<4.1	4.1	Operating voltage limit
S4	9	AMSAT	CN1	MPPT Efficiency	Percentage	90.00%	>90%	Conversion efficiency
S5	9	AMSAT	CN1	MPPT Response Time	Milliseconds	100	<100	
S6	9	AMSAT	CN2	Maximum Operational Temperature	Celsius	85	>85	Industrial Specifications
S7	9	AMSAT	CN2	Minimum Operational Temperature	Celsius	-40	<-40	Industrial Specifications
S8	9	AMSAT	CN2	TID Radiation Expectation	kiloRad	30	>30	Published data
S9	6	AMSAT	CN2,CN4	Component Height Restriction	Millimeter	<8.1	5	Topside clearance
S10	6	AMSAT	CN2	Layout Area Constraint	Cm^2	144.5	<144.5	Tall items on topside
S11	6	AMSAT	CN5,CN6	IHU Communications	Pass/Fail	N/A	N/A	Fox-1 Specifications (I2C)

IHU Internal Housekeeping Unit

Importance Rating Scale

Must have 9
Nice to have 6
Preference 3

Figure 7: Fox-2 MPPT engineering specifications as agreed upon with AMSAT Engineering.

KySat-2 Announces Telemetry Dashboard Software and Tracking Aids

The KySat-2 CubeSat launch is scheduled as part of the ORS-3/ELaNa-4 mission on November 19 from Wallops Island, VA. The Kentucky Space Team requests that Amateur Radio stations track and help in the collection of telemetry data.

To help track KySat-2, a web page has been setup to assist radio amateurs. To help decode packets from KySat-2, software for radio amateurs to download and install is available at: <http://ssl.engineering.uky.edu/amateur-radio-operators/>

Initially, the software will support receive-only operation, but after spacecraft checkout, it is intended that the software will also support limited commanding.

An Advanced Satellite Orbit Tracking Tool to visualize KySat-2's orbit in real-time can be viewed at: <http://k2asot.engr.uky.edu/>

For more information on general information on KySat-2, visit: <http://kysat2.engr.uky.edu/> and <http://kentuckyspace.com/>



AMSAT President Barry Baines, WD4ASW has accepted the resignation of Mark Hammond, N8MH as VP-Educational Relations and appointed E. Michael McCardel, "EMike", KC8YLD as his replacement.

Mark Hammond, N8MH of Coats, NC has served as VP-Educational Relations since December 2011. During his tenure, Mark established a team focused on educational issues and supporting the educational objectives of AMSAT. A highlight for the team was the ARISS contact conducted during the 2012 Pacificon Convention in October 2012 in Santa Clara, CA that provided an opportunity for a group of selected young people from the Santa Clara area to ask questions directly to an astronaut on board the International Space Station with an audience of the participant's family members and amateur radio operators in attendance. Managing a school contact during an ARRL Convention provided a unique opportunity to highlight ARISS before a much wider audience that appreciated both the technical details of communications technology and the wonder of students speaking to an astronaut. Members of Mark's Education Team, including Joe Spier, K6WAO, Dale Hunzeker, KJ6VUC and EMike were all involved in the management of the ARISS contact at Pacificon.

In his 22 months of service, Mark developed a strong working relationship with the ARRL Education Department, NASA Education at Johnson Space Center, various universities which AMSAT had established working relationships, plus AMSAT members interested in finding ways of placing amateur radio satellites in the classroom. Mark has served as a member of the review team (which included ARRL and JSC Education) which evaluated applications for ARISS school contacts. His close working relationship with Mark Spencer, WA8SME encouraged "Spence" to develop some creative educational concepts, such as the Fox-1 Attitude Determination Experiment Simulator that was featured in the July/August 2013 of the *AMSAT Journal*. Mark also represented AMSAT-NA at the 2012 AMSAT-UK Space Colloquium at Guilford, which provided an opportunity for him to interact with the AMSAT-UK FUNCube-1 team responsible for developing educational materials in support of that satellite's educational objectives.

Mark's resignation is due to his appointment effective September 1, 2013 as vice president of academic affairs and provost of Campbell University, Buies Creek, NC. The increased



EMike McCardel, KC8YLD, AMSAT VP- Educational Relations

workload and travel associated with his new position has forced Mark to re-evaluate his diminishing available time. His conclusion was that he could not devote the time necessary to fulfill his AMSAT educational responsibilities.

AMSAT President Barry Baines, WD4ASW notes, "Mark re-invigorated a critical area for AMSAT, establishing new relationships with key organizations outside of AMSAT and helping us to better understand and respond to the challenges of fulfilling our vision of using amateur radio satellites in support of STEM (Science, Technology, Engineering and Mathematics) in the classroom. AMSAT's loss is Campbell University's gain, and we wish Mark well in his new position." Barry also observed, "Fortunately for AMSAT, Mark will serve as a member of the AMSAT Board of Directors, having just been elected by the AMSAT membership, which allows AMSAT to benefit from Mark's insight and perspective in dealing with AMSAT's strategic issues."

Mark's leadership on education has enhanced AMSAT's focus on an important aspect of AMSAT's mission. "Over the past two years I've had the distinct pleasure of interacting with some very capable individuals who are passionate about integrating amateur radio satellites into the classroom as well as working with individuals who make the ARISS program such a worldwide success," reflected Mark. "I have every confidence in EMike as he continues to further enrich AMSAT's education outreach program by not only continuing initiatives already set into motion, but by establishing new and exciting ones as well."

With Mark's resignation, the appointment of "EMike" McCardel, KC8YLD of Danville, OH as the new VP-Educational Relations is also announced. First licensed in 2003, EMike's initial interest in amateur radio

was due to the ISS and the desire to interact with the astronauts on board. That initial interest broadened in its scope to include amateur radio satellites and AMSAT, joining in 2011 and was subsequently drawn to the educational outreach efforts of Mark Hammond's new Educational Relations team.

EMike's professional background incorporated teaching and working with young people inside and outside the classroom, including having worked with the developmentally disabled. For the past 18 years, he has served as an IT manager at Kenyon College, Gambier, OH as a member of the college's Library and Information Services Department. EMike retired from Kenyon this past June.

McCardel's interest in education outreach has also been reflected in his volunteer work under the ARRL with the "Ohio Section Educational Outreach Initiative" which EMike notes, "focuses on building relationships with teachers and students beginning with our own children and grandchildren and their teachers. As teachers become aware and have a better understanding of our resources, they adjust to find ways to fit it into the curriculum."

From this experience, EMike is hopeful that the focus on reaching out to teachers can be encouraged under AMSAT. "I hope to expand on this theme with AMSAT while continuing to build the strong relationships Mark has been developing with our Colleges and Universities. I am challenged to follow in Mark's shoes. He has been a good mentor and friend and I believe that he constructed a firm foundation upon which we can build and move AMSAT's educational outreach forward."



The Russian Dnepr rocket launch on November 21 from Dombarovsky near Yasny carried 32 satellites, many of which are amateur radio or experimental using amateur radio frequencies.

Nader, ST2NH has developed graphics depicting the known satellites on the launch, as well as published frequencies of those using amateur radio. Nader's blog can be found at:

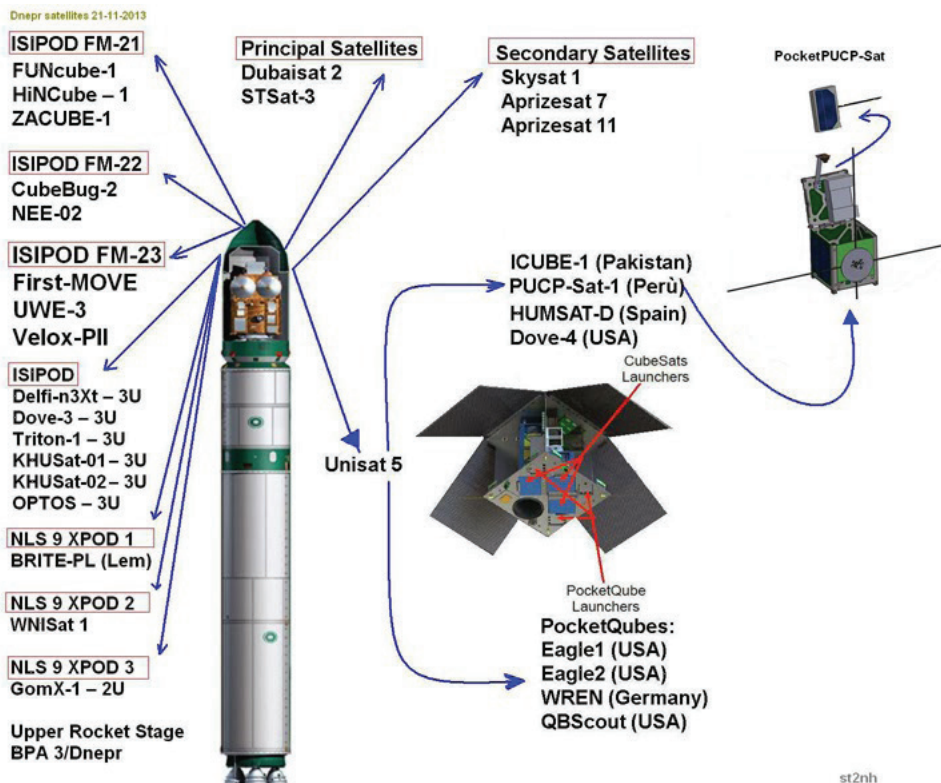
<http://st2nh-blogger.blogspot.co.uk/>

A full list of known payloads can be found at

<http://www.zarya.info/blog/?p=1745>

Several of these satellites are expected to provide opportunities for two-way amateur communications via linear transponders, FM to DSB repeaters, or digital links.

FUNcube-1 from AMSAT-UK and AMSAT-NL is a 1U cubesat that includes an educational beacon and 20 kHz wide linear transponder. Detailed info is at:



st2nh

Name	Size	Nationality	Main Downlink		2nd DL Freq	Beacon Freq	S-band DL	Transponder DL		Transponder UL	
			Fre-quency	Modula-tion				min	max	min	max
HiNCube	1U	Norway	437.305	GMSK							
FUNcube	1U	NL	145.935	1k2 BPSK				145.950	145.970	435.130	435.150
ZACUBE-01	1U	Sth Africa	437.345			14.099					
First-MOVE	1U	Germany	145.970	1k2 BPSK AX.25							
UWE-3	1U	Germany	437.385	FSK							
Velox-Pil	1U	Singapore	145.980	1k2 BPSK							
Cubebug-2	2U	Argentina	437.445								
Triton-1	3U	NL	145.815		145.860						
Delfi-n3Xt	3U	NL	145.870		145.930		2405.000	145.880	145.920	435.530	435.570
GOMX-1	2U	Denmark	437.250								
UNISAT-5	Microsat	Italy	437.425		437.175						
Wren	PocketQube	Germany	437.405								
Eagle 1 (Beaker-Sat)	PocketQube	USA	437.465								
Eagle 2 (\$50Sat)	PocketQube	USA	437.505								
QBScout1	PocketQube	USA	437.525								
PUCPSat-1	1U	Peru	145.840			437.200					
PocketPUCP	8x4x1.8 cm	Peru	437.200								
HumSat-D	1U	Spain	437.325								
estar-2	1U	Italy	437.485								
Icube-1	1U	Pakistan	145.947								

Table 1: Frequency and Operating Mode of DNEPR Launch Satellites

<http://funcube.org.uk/>

and

<http://amsat-uk.org/funcube/funcube-cubesat/>

Delfi-n3Xt is a 3U cubesat from Delft University of Technology that includes a 40kHz wide linear transponder and high speed S-band downlink. Detailed info may be found at:

<http://www.delfispace.nl/index.php/delfi-n3xt>

Delfi-n3Xt is currently configured to transmit when in the Sun and is off in eclipse to save battery power. The Delfi team has noticed that the DUDE telemetry client does not properly indicate the frequency offset and it is very difficult to get a lock on the signal. They are investigating the Costas PLL inside DUDE to see if they can improve its performance. Meanwhile, Delfi-n3Xt remains challenging to decode packets until software updates are available.

Triton-1 is a 3U cubesat from ISIS-BV (Innovative Solutions In Space BV) with a AIS (ship location service) radio science experiment. After the experiment is complete (est. 3 months), the spacecraft radios will be reconfigured to U/V FM to DSB ("AO-16 mode") repeaters open for amateur use. More info is at:

<http://www.isispace.nl/HAM/>

CubeBug-2 is a 2U cubesat from the Argentinian Ministry of Science, Technology and Productive Innovation, INVAPS.E., Satellogic S.A., and Radio Club Bariloche. It is a technology demonstration mission, with digipeater and data downloads open after initial experiments. See:

<http://2.cubebug.org/>

and

http://www.amsatuk.me.uk/iaru/finished_detail.php?serialnum=310

FUNCube-1 Primary Mission is Educational Outreach

The purpose of the FUNCube project is to provide a signal *directly* from a satellite in space that can be easily received by schools and colleges. The target audience is mainly students at both primary and secondary levels. The information will be displayed in an attractive format and provide stimulation and encouragement for students to become interested in all STEM (Science Technology Engineering & Maths) subjects in a unique

way.

As well as building the actual satellite, the team has developed a simple and cheap "ground station". This simply requires a small aerial, preferably outdoors, which connects to a special FUNCube USB dongle. This will receive the signals directly from the satellite and transfer the data to specially developed graphical software (the Dashboard) running on any Windows computer.

FUNCube-1 Transponder

AMSAT-UK has announced the FUNCube-1 mode UV Inverting transponder will operate with the following specifications:

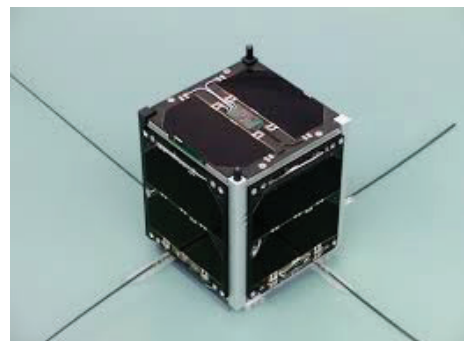
- Power output 300mW PEP, includes 30mW telemetry on 145.935MHz
- AGC range 43dB
- Educational mode : BPSK telemetry at 300mW
- Amateur mode : 30mW BPSK telemetry plus full power transponder
- Satellite can auto switch from "educational" in sunlight to "amateur" in eclipse
- Transponder uplink 435.150 to 435.130 MHz
- Transponder downlink 145.950 to 145.970 MHz
- Telemetry beacon 145.935 MHz
- All frequencies have been coordinated with IARU (International Amateur Radio Union).

Telemetry From FUNCube-1

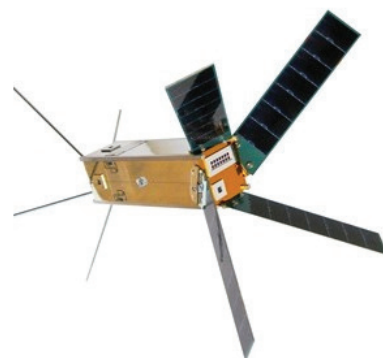
- 1200 bps BPSK with forward error correction, 54 channels
- Telemetry sent in 24 x 5 second frames over a 2 minute period
- Whole orbit data sampled every 60 seconds and stored for 104 minutes
- 'Fast' data sampled at 1 second intervals for 60 seconds
- 9 x 200 character greetings messages; 27 messages stored in memory
- 4.3 seconds of data plus 0.7 seconds of unmodulated BPSK tone

Full details of FUNCube-1 operating modes, data protocols, availability of ground station "dashboard software", and the user handbook can be found at:

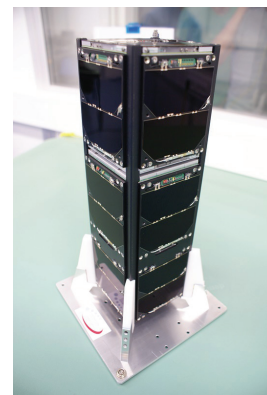
<http://funcube.org.uk/>



FUNCube-1



Delfi-n3Xt



Triton-1



CubeBig-2



Arthur Payne, VE3GNF
Photos by Keith Baker, KB1SF / VA3KSF

During the past few years it has fallen on my shoulders to provide the Satellite station for the Lambton County Radio Club (Sarnia, Ontario, Canada) Field Day operation. To that extent, I have built numerous antennas and az-el mounting systems. These have resulted in our making the satellite contacts that gave the Club those extra points for such efforts.

This last year, when it came time to again assemble our station, I was intrigued by an article in the March /April 2013 issue of the *AMSAT Journal* by Rick Tejera, K7TEJ.

Rick wrote about an equatorial mount for satellite antennas using one designed for a small telescope and adapted for satellite tracking. Having the same interests as Rick, I believed that I could produce a functioning system “really cheap”. Thus, the birth of what I call “The Gizmo”. The parts to construct one yourself should be readily available at your local hardware or “big box” store.

To build The Gizmo, I used a ½ inch copper plumber’s tee and four, 5/8 by 1 inch, 1/2 inch ID bushings, a piece of ½ inch aluminum rod (about 2 feet long) and a few hand tools to construct a functioning equatorial mount.

Preparation is quite simple. First, I cut off about 1 inch of the rod and dressed the ends. This can be done with a file (I used my mini-lathe, but, that’s just because I have one). I then drilled and tapped the piece with a Number 7 drill bit and a ¼ - 20 tap, keeping the rest of the rod to use as the main shaft.

Next, I threaded the short piece that I have already tapped onto a standard camera tripod. I pushed three of the bushings into the orifices of the tee and the fourth into the end of my Arrow antenna. I then fed the remaining rod through the Tee into the bushing in the end of the Arrow antenna and passed just enough of the rod through the bushing so that I could secure the main rod with a ¼ -20 1-inch sized screw on to my Arrow antenna. I used a counterweight I had from an old telescope mount to balance the system and positioned it on the rod so the antenna rotated easily and freely.

If you do not have a commercial counterweight it is easy to build a usable one by cutting a small hole in an empty soup can so a piece of ¾ inch PVC tubing can pass through it. Then, fill the can with cement.

This produces a weight of about 1.5 pounds (680 grams approx). Be sure to slit the part of the tubing that comes out of the can and tighten it onto the main shaft onto the rod by using a hose clamp. Then simply position it on the rod



A soup can counterweight for the Gizmo made from a split PVC pipe and a stainless steel hose clamp. The can is filled with cement. (KB1SF photo)

for proper balance.

Operation of The Gizmo is very easy once you have balanced the antenna by adjusting the counterweight on the rod. First, set the tripod so that the front leg faces north (a compass will come in handy here). Then, set the tilt angle of the head of the tripod to the angle that the satellite will reach at its maximum elevation for the satellite pass (derived from the software you are using to predict the pass). Secure the head at that angle by twisting the tripod’s altitude handle so that it’s tight.

To assist in determining the maximum altitude setting, a plastic protractor (such as the kind included in any dollar store school geometry kit) can be attached to the tripod plate. Then, a string and weight can be added to show the actual angle, much like a plumb bob does.

Next, once you’ve set the tripod head to the maximum altitude for the pass, rotate the azimuth part of the head of the tripod to the direction of maximum elevation for that pass. Then, secure the azimuth clamp on the tripod. You should be able to swing the antenna mounted to The Gizmo left or right so that the boom of the antenna is both parallel to the ground and pointing in the direction at the horizon where AOS will occur.

Now, when the satellite comes into view, all you need to do is simply rotate the antenna in a sweeping arc from AOS horizon to LOS

horizon as you track the satellite across the sky. What’s more, if you need to change the polarity of your antenna during the satellite pass, the Gizmo allows you to easily rotate the antenna in the mount with just a twist of your hand.

Needless to say, I used The Gizmo to make several solid contacts with FO-29 during this last year’s Field Day operation. And, the system worked so well that my plan is to leave all of my fancy, wired up, Az-El satellite antenna rotators at home and just use this new, incredibly simple antenna mount for next year’s Field Day event.

My thanks go to Keith KB1SF/ VA3KSF for his encouragement in documenting this effort and for rekindling my interest in satellite operations. Also, thanks go to The Lambton County Radio Club (VE3SAR) for giving me the opportunity to provide their satellite station at Field Day and to Chet VE3CFK for his 40 years of friendship that, for me, have helped make ham radio *really* fun! 📡





The soup can counterweight mounted on the Gizmo.
(KB1SF photo)



Here's the basic Gizmo with the counterweight, main shaft, plumbers tee and bushings installed. Note the drill stop between the tee and the weight. This addition is not necessary but I found it handy so that the shaft didn't slide in the tee when attached to the antenna. Also note the short stub attached to the tripod. (KB1SF photo)



(above) This photo shows the short stub screwed into the tripod head. The angle of maximum elevation of the upcoming satellite pass is set with the tripod's elevation control. Here it's set to about 45 degrees.



(right, top) The author is shown here with the antenna and Gizmo mount ready to assemble for the next satellite pass.



(right, bottom) In this photo, the Gizmo is attached to the antenna and mounted on the tripod ready for use. (KB1SF photos)



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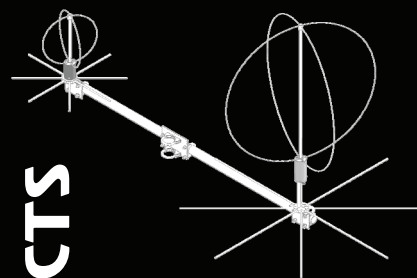
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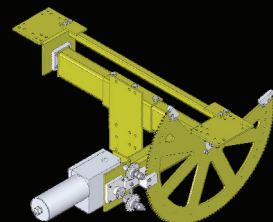


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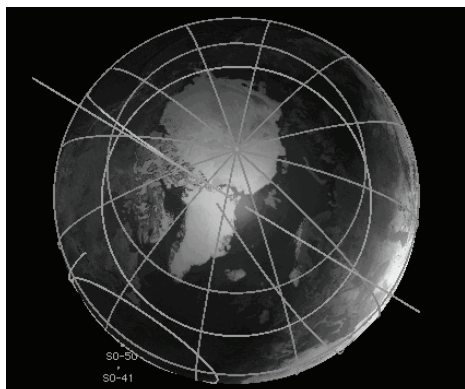
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Patrick Stoddard, WD9EWK Named New Director Field Operations

AMSAT President Barry Baines, WD4ASW has announced the appointment of Patrick Stoddard, WD9EWK as AMSAT's new Director of Field Operations. In his new capacity, Patrick is responsible for managing AMSAT's corps of Area Coordinators (AC) who represent AMSAT in their local areas. Area Coordinators serve as the "Ambassadors of AMSAT" which includes such activities as manning an AMSAT booth at hamfests, giving local/regional club presentations on AMSAT and satellite operations, and serving as "Elmers" to those looking for information about operating through satellites. ACs are also known to establish local nets and assist with Field Day satellite activities.

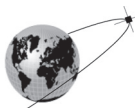
"Patrick is well qualified to lead AMSAT's field organization having served as an Area Coordinator and representing AMSAT at many hamfests as well as giving club presentations," notes Barry. "His willingness to give satellite demonstrations at numerous hamfests has given many people their first experience in working the satellites. He understands what is required to help build AMSAT awareness within the local amateur community."

Organizationally, Patrick will report to AMSAT VP-User Services Gould Smith, WA4SXM. He will also work closely with AMSAT President Barry Baines, WD4ASW as Patrick begins the process of reviving the Field Ops organization. At one time, over 100 AMSAT members were listed as Area Coordinators in the US and Canada. However, the passing of Dee Interdonato, NB2F in 2012 has meant that the field organization has not received the attention that it deserves. The loss of the AMSAT website in January 2013 also resulted in the loss of the "Field Operations Support System" (FOSS) which played a critical role in managing the field organization. This capability will hopefully be restored in the near future on AMSAT's revived website. A key benefit of FOSS is the ability to share presentation materials and other documents for use by Area Coordinators as well as serving as a mechanism for individuals to reach out to Area Coordinators. "I look forward to reviving the Field Organization and re-establishing a line of communication with those who want to represent AMSAT at the local level," said Patrick. "I will be reaching out to those that have assisted us in the past to ascertain their current level of interest in helping AMSAT as well as encouraging others to join our team."



Patrick Stoddard, WD9EWK (left) and John Papay, K8YSE/7 (right) at the Tucson Hamfest, November 9, 2013.





Organizational Changes

This issue of the Journal notes the appointments of E. Mike McCardel, KC8YLD as AMSAT's new VP-Educational Relations and Patrick Stoddard, WD9EWK, as Director-Field Operations. One other change worth noting is the resignation of James French, W8ISS as the ANS Weekly Satellite Report Editor. James for many years released weekly information concerning the operational status of amateur satellites as part of the AMSAT News Service (ANS), releasing bulletins that dealt just with satellite status. James notified me in early October that he wished to resign as Editor effective 1 NOV 13. James had been serving as Editor of over 10 years; his dedication and long service are certainly appreciated.

Drew Glasbrenner, KO4MA has agreed to serve as team leader for a group that will carry on the task of keeping us informed of satellite status and developments. As the number of amateur satellites continues to grow (witnessed by the number of satellites placed in orbit in November) and as the number of satellites under development expands, the management of maintaining up-to-date information becomes more complex; expect to see changes in how this information is managed and conveyed. Drew serves as AMSAT's VP-Operations and has developed an extensive network of contacts within the amateur satellite community. Drew will be looking at providing information as developments occur, through the Weekly ANS as well as via the AMSAT website. As universities develop their programs, he'll be looking to provide appropriate links to their websites as presumably the best source of information concerning a particular satellite is the group building the satellite.

Drew's team will provide an important conduit of information as it becomes clear that we will see more satellites suitable for amateur satellite communications. There appears to be a general perception within the amateur radio community that amateur radio in space has reached its zenith and that we're now in a declining period of interest and activity. That is certainly not the case given the rise in the number of amateur radio satellites being built and launched. AMSAT's Fox-1 cubesat has been assigned a launch in late 2014 and our RadFxSat/Fox-1B has yet to be manifested. We're building two additional Fox-1 class cubesats (total of four), meaning that we'll be ready to place two more of this class of satellite into orbit when the opportunity arises, based upon

partnering with a university payload that will support the justification for NASA ELaNa program selection.

The AMSAT Office

By now many of you have heard that AMSAT's Office Manager, Martha Saragovitz injured her Achilles Heel that has seriously impeded her mobility. Her injury precluded her ability to attend the AMSAT Space Symposium and she has been very limited in being able to get to the AMSAT office in Silver Spring, MD. In essence, the office has been closed.

Since her injury on 22 OCT 13, her left foot has been in a series of casts and she cannot put any pressure on it. By the end of November she'll be wearing a boot that will hopefully allow her more mobility. It remains to be seen how soon she can return to a regular (if limited) office hour schedule. Recovery from this type of injury typically takes six to eight weeks, meaning it could be the end of the year before Martha returns to work fulltime.

Please be patient as Martha recovers from her injury. We have a one-person office, so when she's not able to be at the office, things don't get accomplished. If you ordered items from the AMSAT Store or renewed your membership, there have been significant delays in the processing of your request. It will be handled when Martha is in position to do the work. Unfortunately, we don't have volunteers who can cover the functions that Martha handles, so again I ask that you bear with us as Martha recovers.

Holiday Greetings

Best wishes this holiday season! AMSAT has accomplished much in 2013 and amateur radio in space certainly received a huge boost with the recent launch of new satellites. As we look forward to 2014, I see much to be optimistic about the future for AMSAT and amateur radio.

FUNcube-1 Designated AO-73

To: Mr Wouter Weggelaar PA3WEG,
Mr Jim Heck G3WGM,

From: William Tynan, W3XO

Congratulations on the successful launch of the FUNcube-1 CubeSat, launched this morning from Yasny in Russia at 07:10:10.47 UTC November 21st 2013.

Since FUNcube-1 meets all of the requirements for being issued an OSCAR number, including coordination through IARU and requesting such a number; I, under authority vested in me by the President of AMSAT-NA, do hereby name FUNcube-1, "AMSAT- OSCAR-73" or "AO-73."

I, and all at AMSAT-NA, wish AMSAT-OSCAR-73 great success in fulfilling all of its mission objectives and we welcome it to the long list of Amateur Radio satellites.

73,

William (Bill) Tynan, W3XO
OSCAR Number Administrator



Florida SwampSat Team Request Assistance

The SwampSat team at the University of Florida is requesting assistance in collecting telemetry from their 1U cubesat, which was successfully launched on the NASA ELaNa Minotaur Launch from Wallops Island on November 20.

The SwampSat beacon will transmit on 437.385 MHz, AFSK modulation, AX.25 9600 baud. The 1 watt downlink will be active on a 60 second interval.

The call sign is WG4SAT. Any operators who are able to copy telemetry are encouraged to send it to telemetry at swampsat.org. Telemetry strings can be pasted into the email body, or attached as a text file. Please include your call sign in telemetry submissions.



Tom Deeble, KA6SIP
ka6sip@aol.com

Since I enjoy working the sats while portable, I volunteered to do some demos at PACIFCON/ARRL National Convention in Santa Clara, October 2012. It was fun being able to use the call W1AW/6. Before the demos I contacted one of our experts on portable operations – Patrick, WD9EWK. After getting some pointers and files to use as handouts, we started talking about John, K8YSE, only needing 9 more grids to complete contacts in all 488 Maidenhead Grid Squares within the 48 contiguous United States. Thinking that a grid expedition might be fun, I contacted John, who seemed very interested in the prospect. Patrick had volunteered to go to Washington for one of the grids, so eight remained. One of these, CN72, is on the southern Oregon coast, and seemed like it required a separate trip. The remaining seven grids clustered around NW Nevada, SE Oregon & northern California, and consisted of DN02, DN10, DN11, DN12, CN81, CN91 & CN92. This seemed like a good excuse to go on a grid expedition and get these 7 grids for John, and also for other hams as these are rare grids.

Not being familiar with the area, I had to buy three sets of map books that show latitude & longitude and that I could mark up with the grid boundaries. Then I had to look at a route and what campgrounds or hotels there might be along the way. This turned out to be a much bigger task than I expected as some of the places we would be traveling to were remote.

Equipment

At PACIFCON I had run the demos of linear satellites using a twin Yaesu FT-817 setup similar to the setup from Dave, KB5WIA. Each radio was connected to an Arrow antenna via coax cables with BNC connectors. I also used the Arrow duplexer mounted inside the boom, on the 2-meter coax as a low-pass filter. This setup worked well. I then decided to swap out one FT-817 with an FT-897, but it seemed that no matter what I tried, I was never satisfied with the results, so I went back to the twin FT-817s at the last minute. One thing I did change was that I ran both radios and preamps from an external 28 Ah SLA/AGM battery instead of using the internal batteries. This way I could run several days without worrying about low voltage. Since it looked like the portable work could be done based out of my pickup, I tried mounting the radios &



KA6SIP Equipment setup for linear sats



Day 3: Linear Operation from DN10/DN11



Day 4: SO-50 from DN12



Day 6: SO-50 from DN02 traveling to Goose Lake, OR



Day 7: AO-07b from CN92



Day 8: Sad sight of top section of Arrow antenna after driving over it

preamps to a board that could travel pretty much as-is between locations and cut down on the set up time.

For SO-50 I decided it would be nice to run my original setup: Arrow antenna, ICOM IC-W32 dual-band radio and Hamtronics 440 preamp. This served me well when HO-68, AO-51 & AO-27 were still available. This setup is mounted on a tripod along with a clipboard to hold my paper log and a small digital recorder. It's nice that I can carry the entire setup around if needed, and proved to be very helpful at one point on the trip.

Day 1, Thursday May 30th

After getting frazzled gathering up all the radio and camping gear, and then loading it all into the truck & trailer, we were finally off late in the day to drive I-80 over the Sierras to Boomtown KOA just west of Reno, Nevada.

Day 2, Friday May 31st

After breakfast and a quick trip to Cabela's, we're off to Winnemucca, Nevada, via I-80. After setting up our trailer we tried an AO-7 pass from our campsite on the south side of I-80 in DN10, with two contacts. At least we knew the gear was running OK! All was well so far, so for the next pass because the RV park was getting full, we found a spot near our campground but on the north side of I-80. Just before 9 PM five contacts were made on FO-29, including K8YSE for grid #1 of 7. We were off to a good start.

Day 3, Saturday June 1st

This ended up being a very busy and tiring day. We scheduled 7 passes and found out that was too many for us to handle in one day. I started out across I-80 again in DN10 around 8 AM with a VO-52 pass. Only two contacts there. I then drove down a dirt road to look for the DN10/DN11 grid line. I was very pleasantly surprised to find it at the intersection of two dirt roads in a turn-around dirt area. After marking the line in the dirt I headed back to camp. Debbie and I would head out there 6 more times that day and make contact with K8YSE for grid #2. The last pass was on VO-52, and I decided then that it was taking too long to find myself on the downlink for only a few contacts and so decided not to try anymore VO-52 passes. With 42 contacts for the day things were looking positive.

Day 4, Sunday June 2nd

This was the day to drive 75 miles north to get into grid DN12. A quick operation



from DN10/DN11 on FO-29 was made after breakfast. After getting gas and coffee, we hit the road and then realized we were running late. This wasn't a good start to the day. Pushing the speed limit a little, we were able to get to the small town of McDermitt, on the border of Nevada and Oregon in plenty of time. Traveling north about one mile past the border we found a dirt road to make our first pass from DN12. This was a SO-50 pass to the east and 13 contacts were made, including grid #3 for K8YSE. The next pass, also SO-50 but now to the west, started out fine but then the battery in the IC-W32A started going dead. I thought the battery was fully charged before the trip but now it was looking like I should have charged it the night before! After a frantic search in the travel bag, the backup battery was found and put into service. We were back on the air for a few more contacts making a total of 6 contacts. I was so relieved that this didn't happen during the first pass to the east. We headed into town for a quick late lunch and then back out to the dirt road. This time we drove about a mile down the road to get away from power lines. We made 9 contacts on AO-7.

We then headed back to our camp in Winnemucca only to find that the wind had really come up. Because we left the windows open in our trailer we found a nice coating of fine sand on most everything. Ten more contacts were made on an evening pass of FO-29 from the DN10/DN11 grid boundary.

Day 5, Monday June 3rd

This was a travel day to Denio Junction, Nevada, and to the town of Denio, Oregon, just to the north. This was a very desolate drive but interesting country. After checking into the 7-room hotel (our only non-camping night), we headed north to get into DN02. Finding a dirt road leading off to the east, we set up for a pass of SO-50, with 12 contacts. We made contact with K8YSE for grid #4. A total of four passes, including AO-7 and FO-29, were made that day. This included operating from DN01 in the middle of a dirt airfield at Denio Junction. Fortunately for us, the airfield doesn't see much action these days.

Day 6, Tuesday June 4th

A morning pass of FO-29 was made from DN10 in the middle of the airfield again. Then after breakfast at the cafe, we headed to Goose Lake State Park in Oregon, just south of Lakeview Oregon. A stop was made along the way in DN02 to operate SO-50. The pass



Day 9: SO-50 from CN81/CN91 grid boundary



Day 10: Last Pass - FO-29 from CN91



Follow up mini-expedition: AO-7 Mode B from CN72 - grid #488 for John, K8YSE

was quiet at first and I got the chance to talk with Kerry, WC7V, for a short while.

It turns out that Goose Lake SP sits right on the California/Oregon border, and we could drive right to the edge of the lake to operate from CN91. We operated on one pass of FO-29 that evening to check things out and were lucky enough to make a contact with K8YSE for grid #5.

Day 7, Wednesday June 5th

Today was an easier day with only 2 passes from CN91 from right at the park, and one from CN92. To get to CN92, we had to drive several miles north, but then the mountains to the east looked like they might interfere with passes. We drove down a county dirt road near the top of the lake to try to get farther away from the mountains. Finding a spot close to when AO-7 would be coming, we set up for the AO-7 pass. Contact with K8YSE was made for grid #6. We were starting to feel confident that maybe we would really be able to make all 7 grids for John on this trip.

Day 8, Thursday June 6th

Debbie decided to stay at the campsite while I operated at the lake shore. Things seemed to be going well. I operated an FO-29 pass around 10:30 AM. After the pass, I had to climb into the back of the pickup, which had a camper shell, to get a bag of clothes at the front. I was leaning on some boxes when one gave way and I fell onto the top section of the split-boom Arrow antenna for the linear radio setup. Fortunately, I was able to bend the elements back into shape. One of the elements really hit my stomach area and left a sore spot for several days. But at least all the equipment seemed to be 100%. I had moved the top section of the Arrow antenna for the dual FT-817 radios to the side of the truck. Not fully checking the area, I backed up the truck to head back to the campsite. Hearing something outside the truck, I stopped only to find that I had driven over the top section! It was a very sad sight! Several elements had broken off, including the 2 Meter gamma matching element. It was clear that this top section was now non-operational!

I tried using the remaining top section with the bottom section for the FT-817s but a burr inside the boom was interfering. Not having a file in the tool kit, I was able to use the inside gripping part of a long-nose pliers as a file to get rid of the burr. Now I was down to one and a half working antennas. This equipment failure and my sore spot had me

wondering if we were going to be able to get the remaining grid for John. One more pass on SO-50 was made before leaving Goose Lake.

After breaking camp we headed to a KOA in Klamath Falls, Oregon. The scenery was interesting going through big farming valleys and forests. I thought Klamath Falls was in the mountains but we found that it is in another huge farming valley, and was hot. We found a nearby sports complex to operate from CN92, and on an evening pass made 9 contacts on SO-50.

Day 9, Friday June 7th

Having operated from CN91 and CN92, I decided we needed to make a trip south back into California to try for CN81 – the last grid needed for K8YSE on this trip. If we had problems we would be able to come back on Day 10. We left late morning to drive to the small town of Macdoel, where the only business is a gas station. Farm fields were all around. We arrived late and at first headed west but found that power lines might be a problem. We then drove across the highway heading east. Thinking we were in good shape, we found a farm road heading south that was clear of power lines. Fortunately, Debbie noticed on the GPS that we had gone too far and were back in CN91, not the CN81 we were there for. After backing up a quarter of a mile, we headed back west. As soon as we got back into CN81 we stopped and set up for the SO-50 pass. I then realized that the satellite was 15 minutes later than what I remembered. So, I walked back down the road to find the CN81/CN91 grid line. It turned out we were only about 200 feet away, so I carried the IC-W32A radio gear

on the tripod down the road to the grid line. Contact was made with K8YSE for grid #7! We finally had grid #7 of 7 in the bag! After the pass, we marked the location and headed to the gas station for a stop and lunch in the shade nearby.

We then headed back to the grid line for an AO-7 pass. There was a farm worker there monitoring a drip irrigation system and I think he really wondered what we were doing. After the pass we headed back to Klamath Falls for a celebratory dinner at Sizzler, and one more CN92 pass.

Day 10, Saturday June 8th

This was going to be a backup day for CN81 but since we were successful the day before we decided to stay in Klamath Falls. Three passes were made from the sports complex. Hector, CO6CBF, e-mailed from Cuba about operating from CN91 and so we decided to go south just across the California border into CN91 for the evening FO-29 pass. We made contact – California to Cuba with QRP gear! With the pass right at sunset we enjoyed watching the sun setting on a lake next to us and hills to the east. Unfortunately, there were hungry mosquitos taking advantage of us. This was pass #33 and our last pass!

Day 11, Sunday June 9th

We were going to try to operate from CN90 this day, but we had a long travel day ahead. We cancelled out on any passes. We drove from Klamath Falls to Lake Tahoe, which was around 350 miles. It was quite a day! We drove through forests and back down to upper desert. At one point it was 103° F. We



FO-29 Sunset Operation from CN71 - Crescent City, CA

could see a storm brewing to the south, and sure enough, we ended up going through it, but after the worst was over. We saw one bolt of lightning strike a ridge and then a short time later noticed it had started a fire. We stopped at a farm road and reported the fire to 911.

Continuing south on highway 395, we decided we had enough gas to make it to Carson City before heading over the mountains into Lake Tahoe. When we arrived, the power was out due to the storm. The traffic lights were also out. We stopped at a Starbucks without power and they gave me a free cup of coffee. I used my flashlight to make a pit stop before we headed out for gas. The station we stopped at didn't have power so we continued south until we found a station with power. Now we were ready to head to Tahoe! However, a station attendant had heard that highway 50 on the Tahoe side was blocked by a fatal accident. So we had to continue south to another pass. We finally made it to Tahoe late evening for 3 nights of rest and recreation before heading back home! Since I operate from Tahoe once in a while, Debbie said no more satellite passes for this trip. After activating 8 grids, I couldn't argue.

Summary

During our grid expedition we operated 33 satellite passes with 246 contacts, all with QRP gear and mostly on linear birds. We were fortunate that AO-7 stayed in mode B for the entire trip. Here are the statistics:

- Grids: 8 total - DN10, DN11, DN12, DN01, DN02, CN81, CN91 & CN92
- Passes: 33 total
- AO-7 Mode B: 10, 78 contacts
- FO-29: 12, 91 contacts
- SO-50: 9, 78 contacts
- VO-52: 2, 4 contacts

This was a fun trip and my wife and I got to see country that we would probably have never ventured into. As you can see, it doesn't take a lot of gear, but it never hurts to have backups! If you haven't tried operating portable, I hope you give it a try, both for your excitement as well as making grids available for other satellite operators.

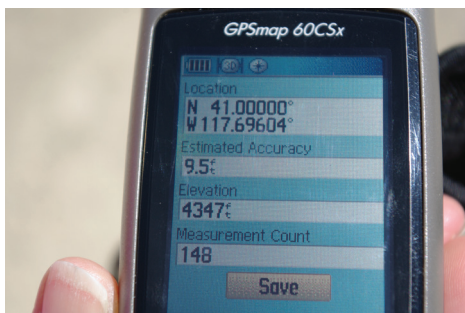
I need to thank Frank, K4FEG, for all his help in getting grid/pass information posted on the internet. There were several times I ended up calling him in the middle of the night with pass information.

Follow up Mini-Grid Expedition

After our grid expedition, Bob, W7LRD, traveled to CN77 to give John his next to last grid and now only CN72 was needed. So, after a vacation with Debbie, I decided to make a quick trip to Brookings, Oregon and operate from CN72, and also CN71 from northern California. This was a short 3-night tent camping trip with meals mostly from McDonalds and Denny's. I was able to put CN72 on the air on AO-7 Mode B and FO-29 Tuesday afternoon August 20th, and made contact with John on both passes. Now John had contacts in all 488 grids! It was exciting to make the final contact and definitely worth the 1,000 mile trip. A total of 12 passes were worked with 93 contacts.

A Happy Ending

I want to add a big thank you to Arrow Antenna! Since my grid expedition I contacted Arrow Antenna about a replacement for the damaged top section. After hearing about the catastrophe and seeing the sad pictures, Tim Chapman, KB7MDF, the owner of Arrow Antenna, graciously sent a replacement antenna! Can't beat that for customer service! Thanks Tim!



(top, left) Using GPS to confirm operation from the DN10 - DN11 grid boundary.

(top, right) Mt. Shasta from the CN81 - CN91 border.

(left) Smokey the Bear visited the campground to investigate who was burning up the bands.



The USA Lower 48 Worked all 488 Grids non-Award

Some of the active grid chasers on the birds are aware that KA6SIP just gave me my last USA grid when he operated from CN72 in Oregon. And I thought it might be interesting to look at the stats and how one manages to work and confirm all 488 USA lower 48 States grids.

Satellite operators come and go and grids come and go with them. A grid might have a very active operator in it and then it is off the air when that person goes away for whatever reason. Interestingly, about half of the 488 grids that were worked were from those operating portable, not in the sense of using a radio with batteries, but in the traditional sense of operating away from their home station location. Once you have experienced being on the other end of a small pileup, you will want to do it again. Just ask W7LRD who tried it recently and is planning another trip (Bob wrote about his trip in the September/November 2013 AMSAT Journal). Here is a list of operators who exited the comfort of their home station and put a grid on the air. The callsign is followed by the number of new grids they gave me towards the goal of working all 488. Others may have been worked but these totals represent the first time a new grid was confirmed.

Jim, ND9M, is a seasoned grid expeditioner. Along with working satellites he is also active on the county hunters nets. Most of his activity was between 2009 and 2011. He was also active from a cargo ship and gave out the very rare DM02. Jim would travel for months at a time and worked from a few hundred grids. Most of that operating was done on FM birds rather than linear ones. It was great to have many daily FM passes when AO-27 and AO-51 were active. HO-68 and SO-67 were in the mix for a while too. 54 new grids came from Jim and he tops the list with working me from 54 grids.

Most everyone knows Patrick WD9EWK. He has done a lot of traveling both in the US and Canada and he gave me 27 new grids. He was very active on the birds until recently. He was an alternate on the AMSAT Board of Directors and was recently appointed to oversee the AMSAT Area Coordinator program. He virtually has no home station and most all local contacts were made from a park near his apartment in Phoenix. He knows how to do it and he is a meticulous planner.

Next on the list is Kerry WC7V. He lives in sparsely populated Montana and travels around by car and in his light aircraft. He went to many grids at my request and made a lot of us very happy by operating from many rare locations. He is in slot number 3 with 19 grids.

Next on the list is Rob KD4ZGW/m. Rob drove an 18 wheeler and we all heard him on a satellite one day. He didn't know his grid square but he knew his milepost on the interstate. From there we had the grid square. Rob went on to improve his mobile station and activated over 100 grid squares. He is no longer driving on long hauls and has not been active for some time. He is fourth on the list with 16 grids.

The next three are very special because they all became new operators during the quest to work all 488. Gail KB0RZD is very active today, usually operating with a handie-talkie. He went to 10 grids around him and sent some photo QSL cards that were just outstanding. He worked me from 9 grids.

KC0YBM operated from his home location for a long time before I realized he was very close to other grids. Chris didn't have portable equipment so I suggested he look into an AC inverter for the car. He did just that and soon he was operating portable from some new grids. This speaks to the ham radio culture that you find a way to operate with what you have. Chris continues to be active and hands out grids in the US and Canada.

And then there is Ted, AA5CK with 8 grids for me. He has operated in grids around his home QTH as well as some rare ones in New Mexico. He lives in EM04, not far from EM05 where I made my first grid expedition contact with KD8CAO from EM05 in front of the White Dog Ranch on old Route 66. I remember Ted's first sat contact.

There are a few very special operators that can't be left out. My son, KD8CAO, provided 8 new grids for his dad. He knows how to operate portable and gives out the grids when he travels. Then there was Richard N2SPI with 6 new grids for me. I asked him about some grids in Maine that hadn't been on and he took the challenge and drove to all of them, getting back to his dad's place during the first snow of the season. Dave KB5WIA made quite the trip by backpacking into CM79. It took two trips to transport the equipment into the grid. His unique trek earned me 4 very rare ones. He has a video of it on YouTube.

I started with satellites in June 2006 and only had 47 USA grids by August, 2008. From August, 2008 till January, 2009 I worked another 109. In 2009 199 were worked. 2010 was 76 and 2011 was 44. Only 4 new grids were worked in 2012 and 9 were snagged in 2013. Eight of those final 9 grids were handed out by Tom KA6SIP. He heard about the need and decided to make a grid expedition to put them on the air. He did 7 of them in one trip. Then Bob W7LRD went to the beach in CN77, operating away from home for the first time. That left CN72. Tom just got back from Hawaii and quickly made plans to camp out in CN72 and gave me the final grid on AO-7B, 20 August 2013 at 2332z. Then he put CN71 on the air on 22-23 August, also a very rare grid square but one that I already had. Many others worked him there.

There is no award for working all 488 grids on satellites as there is for six meters (FFMA). The ARRL awards committee has looked at it and will implement it if someone on the Board of Directors brings it up for a vote and it passes. Hopefully that will happen soon. Having that type of award gives everyone something to work for. It promotes grid expeditions and interest in working through the satellites. If we all contact our ARRL Director, it might just happen.

There may be others who have already worked all 488 grids on satellites. K6YK might be one of them. I know there are several others who are getting close. It is not any easy thing to accomplish even if you operate every day. It is something you can work towards over the years.

I want to thank everyone that made satellite contacts with me that ultimately led to working all 488. Many went out of their way to put on a grid. Over half of the grids worked were from grid expeditions! If you haven't experienced operating away from home, please consider it. With new operators showing up on the birds every day, there is always a need for an uncommon grid. And you will have a lot of fun doing it! Just ask anyone on my list.

73,
John, K8YSE



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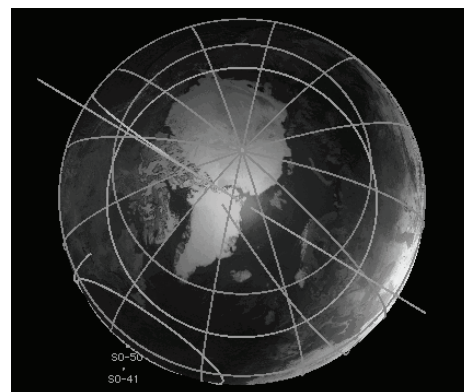
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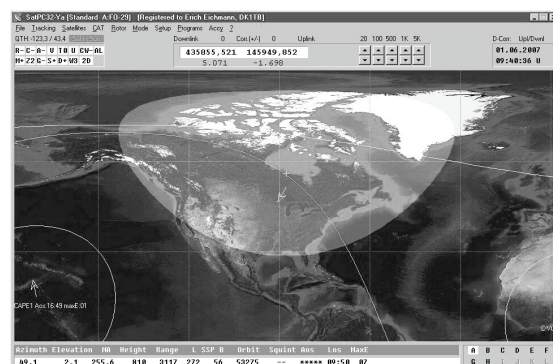


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